

**OROVILLE FERC RELICENSING
(PROJECT No. 2100)**

**INTERIM REPORT
SP-F3.2 TASK 2
SP-F21 TASK 1**


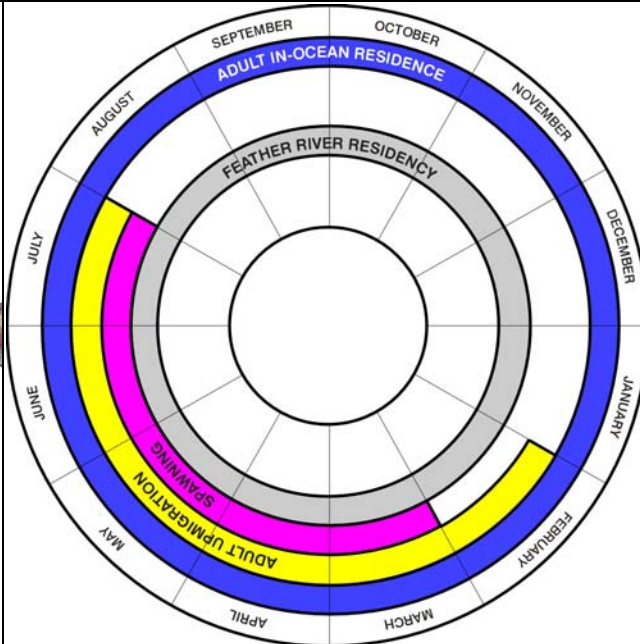
**APPENDIX A
MATRIX OF LIFE HISTORY AND HABITAT REQUIREMENTS FOR
FEATHER RIVER FISH SPECIES**

**LITERATURE REVIEW OF LIFE HISTORY AND
HABITAT REQUIREMENTS FOR
FEATHER RIVER FISH SPECIES**

GREEN STURGEON

JANUARY 2003

Element	Element Descriptor	General	Feather River Specific
General			
common name (s)	English name (usually used by fishers and laypeople).	Green sturgeon	
scientific name (s)	Latin name (referenced in scientific publications).	<i>Acipenser medirostris</i>	
taxonomy (family)	Common name of the family to which they belong. Also indicate scientific family name.	<p>Sturgeon - <i>Acipenseridae</i></p> <p>North American Green sturgeon are possibly related to the Asian form of green sturgeon, but additional work is needed to determine the level of relatedness (Beamesderfer et al. 2002).</p> <p>Green sturgeon are modern relics of ancient bony fishes, which are relatively unchanged from their first appearance 200 million years ago. They are related to paddlefishes and fossil fishes, and are an offshoot of ancestral chondrosteans (infraclass <i>Chondrostei</i>), however, they are likely a different taxon from the Asian form of green sturgeon (Environmental Protection Information Center et al. 2001).</p>	

Element	Element Descriptor	General	Feather River Specific
depiction	Illustration, drawing or photograph.		
range	Broad geographic distribution, specifying California distribution, as available.	<p>Green sturgeon range from Mexico to southeast Alaska, and are the most widespread type of sturgeon. Confirmed spawning populations of green sturgeon are located in the Rogue, Klamath, and Sacramento rivers (Beamesderfer et al. 2002).</p> <p>The ocean range of green sturgeon extends from the Bering Sea to Ensenada, Mexico. Green sturgeon are found in estuaries and bays from British Columbia, Canada, to Monterey Bay, California; and in river mouths from the Skeena River, British Columbia, to the Sacramento River, California. The only freshwater green sturgeon spawning populations are found in Oregon and California (Environmental Protection Information Center et al. 2001).</p> <p>Green sturgeon occur along both the east and west coasts of the Pacific Ocean, with the greatest abundance located between the 40th and 60th parallels (Surface Water Resources 2002).</p>	<p>Although there was no direct evidence, in 1968 tributaries to the Sacramento River such as the Feather River were claimed to have spawning green sturgeon. There are reports of green sturgeon caught by sport fishermen in the Feather River in 1995. The presence of larval green sturgeon in salmon outmigrant traps indicates that the Feather River may prove to be a principal spawning area (Environmental Protection Information Center et al. 2001).</p> <p>Despite reports of observations of adult green sturgeon in the Feather River, directed efforts were unable to collect eggs and larvae (Beamesderfer et al. 2002).</p> <p>Angler catches of green sturgeon in the Feather River suggest that the Feather River may be a major spawning ground (Habitat Conservation Planning Branch 2002).</p>

Element	Element Descriptor	General	Feather River Specific
native or introduced	If introduced, indicate timing, location, and methods.	Green sturgeon are native to California (Beamesderfer et al. 2002).	
ESA listing status	Following the categories according to California Code of Regulations and the Federal Register, indicate whether: SE = State-listed Endangered; ST = State-listed Threatened; FE = Federally listed Endangered; FT = Federally-listed Threatened; SCE = State Candidate (Endangered); SCT = State candidate (Threatened); FPE = Federally proposed (Endangered); FPT = Federally proposed (Threatened); FPD = Federally proposed (Delisting); the date of listing; or N = not listed.	Green sturgeon currently have no status under the federal endangered species act (ESA) (National Marine Fisheries Service 2002); however, the Environmental Protection Information Center (EPIC), Center for Biological Diversity (CDB), and WaterKeepers Northern California (WaterKeepers) filed a petition with the National Marine Fisheries Service (NMFS) in June 2001 to list the species as "endangered" or "threatened" (Environmental Protection Information Center et al. 2001).	
species status	If native, whether: Extinct/ extirpated; Threatened or Endangered; Special concern; Watch list; Stable or increasing. If introduced, whether: Extirpated (failed introduction); highly localized; Localized; Widespread and stable; Widespread and expanding.	Green sturgeon are anadromous and are classified as a species of special concern (Moyle 2002). Little is known about green sturgeon because of their generally low abundance, limited spawning distribution, and low commercial and sport fishing value compared to white sturgeon (Environmental Protection Information Center et al. 2001).	
economic or recreational value	Indicate whether target species sought for food or trophy. Whether desirable by recreational fishers, commercial fishers, or both.	Green sturgeon have low commercial and sport fishing value compared to white sturgeon (Environmental Protection Information Center et al. 2001).	
warmwater or coldwater	Warmwater if suitable temperature range is similar to basses; coldwater if suitable temperature range is similar to salmonids.		

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pelagic or littoral	Environment: Pelagic - living far from shore; Littoral - living near the shore.	Although known to disperse widely in the ocean, green sturgeon are commonly observed in bays and estuaries (Beamesderfer et al. 2002).	
bottom or water column distribution	Environment: bottom (benthic) or along water column.	Green sturgeon are a bottom dwelling (demersal) fish (Environmental Protection Information Center et al. 2001; National Marine Fisheries Service 2002).	
lentic or lotic	Environment: Lentic - pertaining to stagnant water, or lake-like; Lotic - moving water, or river-like.		
Adults			
life span	Approximate maximum age obtained.	<p>The life span of green sturgeon is over 50 years (Beamesderfer et al. 2002).</p> <p>The life span of green sturgeon possibly ranges from 60 to 70 years (Moyle 2002).</p> <p>The life span of green sturgeon is over 40 years (U.S.Fish and Wildlife Service 1995b).</p>	
adult length	Indicate: Length at which they first reproduce; average length and maximum length the fish can attain.	<p>Adult green sturgeon can attain lengths of up to 9 feet (2.7 meters). Males mature at 15 to 17 years and are typically 5 to 6 feet (1.5 to 1.8 meters) in length at maturity. Females mature at 20 to 25 years and are typically 6 to 7 feet (1.8 to 2.1 meters) in length at maturity (Beamesderfer et al. 2002).</p> <p>Green sturgeon become sexually mature at approximately 15 to 20 years, with lengths of 51 to 55 inches (1.23–1.4 meters) (California Department of Fish and Game 2001).</p> <p>The maximum size of green sturgeon in the Klamath River was 90 inches (2.3 meters) (California Department of Fish and Game 2001).</p> <p>Green sturgeon grow approximately 2.8 inches (7 centimeters) per year until they reach maturity at 51.2 to 55.1 inches (130 to 140 centimeters), between 15 and 20 years of age (U.S.Fish and</p>	

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		<p>Wildlife Service 1995a).</p> <p>51.2 inches (1.3 meters) is the minimum total length at maturity for female green sturgeon (U.S.Fish and Wildlife Service 1995a).</p> <p>Green sturgeon may reach 7 feet (2.1 meters) in length (U.S.Fish and Wildlife Service 1995b).</p>	
adult weight	Indicate: Weight at which they first reproduce; average weight and maximum weight the fish can attain.	<p>The maximum size of a green sturgeon in the Klamath river was 180 pounds (81.6 kilograms), and was estimated to be about 40 years old. Historical accounts report weights of up to 350 pounds (158.8 kilograms) (California Department of Fish and Game 2001).</p> <p>Green sturgeon may reach approximately 350.6 pounds (159 kilograms), and average 198.4 pounds (90 kilograms) (Environmental Protection Information Center et al. 2001; Surface Water Resources 2002).</p> <p>Green sturgeon may reach 350 pounds (159 kilograms) (U.S.Fish and Wildlife Service 1995b).</p> <p>Adult green sturgeon can reach 350 pounds (159 kilograms), but in the San Francisco Bay, most are probably less than 99.2 pounds (45 kilograms) (U.S.Fish and Wildlife Service 1995a).</p>	
physical morphology	General shape of the fish: elongated, fusiform, laterally compressed, etc.	Green sturgeon are elongated in shape.	
coloration	Indicate color, and color changes, if any, during reproduction phase.	Green sturgeon are olive green in color, with an olivaceous stripe down each side (Environmental Protection Information Center et al. 2001).	
other physical adult descriptors	Unique physical features for easy identification.	Green sturgeon have a mostly cartilaginous skeleton; heavy, sandpaper-like skin; rows of scutes (bony plates) for protection in place of scales; long, narrow, shovel-like snouts with four barbels underneath the snout; and a toothless mouth with portrusible lips (Environmental Protection Information Center et al. 2001).	

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		Similar appearance to white sturgeon (with which they co-occur), except that the barbells are usually closer to the mouth than the tip of the long, narrow snout. There is one large scute behind the dorsal fin, as well as behind the anal fin; both are lacking in white sturgeon (U.S.Fish and Wildlife Service 1995a).	
adult food base	Indicate primary diet components.	<p>Green sturgeon feed on bottom-dwelling animals, including fish (California Department of Fish and Game 2001).</p> <p>Green sturgeon feed on benthic invertebrates, crustaceans, and fish (Surface Water Resources 2002).</p> <p>In bays and estuaries, green sturgeon feed on sand lances, callianassid shrimp, anchovies, clams, and snails (Surface Water Resources 2002).</p> <p>Green sturgeon feed on shrimps, crabs, worms, amphipods, isopods, and small, disabled or dead fish (Environmental Protection Information Center et al. 2001).</p>	
adult feeding habits	Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder.	<p>Green sturgeon feed by suction with their ventral protusible mouths (California Department of Fish and Game 2001).</p> <p>Green sturgeon are opportunistic carvivores and can withstand long periods of deprivation during spawning migrations (Environmental Protection Information Center et al. 2001; Surface Water Resources 2002).</p> <p>Green sturgeon can be active hunters (Environmental Protection Information Center et al. 2001).</p> <p>Green sturgeon are benthic feeders. In Washington state, green sturgeon mainly feed on sand lances (<i>Ammodytes hexapterus</i>) and callianassid shrimp. In the Columbia River estuary, green sturgeon feed</p>	

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		on anchovies, and perhaps also clams (U.S. Fish and Wildlife Service 1995a).	
adult in-ocean residence time	For anadromous species, age when they migrate to the ocean and duration spent in the ocean before returning to freshwater to spawn.	<p>Most of the adult life of green sturgeon is spent in the ocean, where they migrate long distances, in some cases over 200 miles (321.9 kilometers). In the summer and fall, there are large concentrations of adult sturgeon in estuaries (Beamesderfer et al. 2002).</p> <p>Green sturgeon return to freshwater to spawn when they are approximately 20 years old and 4.3 feet (130 centimeters) in length (National Marine Fisheries Service 2002).</p> <p>Green sturgeon move into estuaries and bays to feed and spend most of their adult life in the ocean (Environmental Protection Information Center et al. 2001).</p> <p>Male green sturgeon spend between 3 and 9 years at sea; females spend between 3 and 13 years at sea (Environmental Protection Information Center et al. 2001).</p> <p>Green sturgeon spend most of their life in salt water and apparently spawn every 4 to 11 years during the spring and summer months in freshwater (Pacific States Marine Fisheries Commission 1996).</p>	
adult habitat characteristics in-ocean	For anadromous species, description of the ocean habitat utilized: whether along major current systems, gyres, pelagic (beyond continental shelves) and neritic (above continental shelves) zones, etc.	<p>Green sturgeon are mostly seen along inshore waters to depths of 60 meters (197 feet). Adults reside in subtidal zones and are most often observed in seawater and mixing zones of bays and estuaries, where they feed. In estuaries, green sturgeon are concentrated in deep areas with soft bottoms and move into intertidal areas to feed at high tide (Environmental Protection Information Center et al. 2001).</p> <p>Green sturgeon live in nearshore oceanic waters.</p>	

Element	Element Descriptor	General	Feather River Specific
		<p>bays, and estuaries (National Marine Fisheries Service 2002).</p> <p>Green sturgeon live in euryhaline waters and are typically found in subtidal areas and inshore waters at depths greater than 60 meters (197 feet). Green sturgeon have the tendency to move into estuaries and bays for feeding during high tides, concentrating in deep areas with soft substrates (Surface Water Resources 2002).</p>	
Adult upstream migration (immigration)			
range of adult upstream migration timing	Time of year adults migrate upstream. If applicable, indicate for various runs.	<p>Adult migration begins in February (Beamesderfer et al. 2002).</p> <p>Adults begin to enter the estuary and move up to the Sacramento River in early spring (California Department of Fish and Game 2001).</p> <p>Green sturgeon migrate upstream from February through late July (Surface Water Resources 2002; U.S.Fish and Wildlife Service 1995a). Green sturgeon migrate from late February through late July (Habitat Conservation Planning Branch 2002).</p>	Historical sightings of green sturgeon in the Feather River have occurred in the spring. A single male was radiotagged at Freeport on March 1991 and was tracked to the mouth of the Feather River a few days later. In the Spring of 1993, 7 adult green sturgeons [60.9 to 73.2 inches (1.5–1.9 meters) in size] were sighted at the Thermalito Afterbay.
peak adult upstream migration timing	Time of year most adults migrate upstream. If applicable, indicate for various runs.		
adult upstream migration water temperature tolerance	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	In the Klamath River, the upstream migration water temperature tolerance probably ranges from 44.4°F to 60.8°F (6.9°C to 16°C). No sturgeon were found outside this surface water temperate range (U.S.Fish and Wildlife Service 1995b).	
adult upstream migration water temperature preference	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.		

Element	Element Descriptor	General	Feather River Specific
Adult holding (freshwater residence)			
water temperature tolerance for holding adults	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for holding adults	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.	In the Klamath River, the holding water temperature tolerance probably ranges from 44.4°F to 60.8°F (6.9°C to 16°C). No sturgeon were found outside this surface water temperate range (U.S.Fish and Wildlife Service 1995b).	
water depth range for holding adults	Reported range of observed (minimum and maximum) water depth utilization.		
water depth preference for holding adults	Reported range of most frequently observed water depth utilization.		
substrate preference for holding adults	If bottom dwellers, indicate substrate: mud, sand, gravel, boulders, aquatic plant beds, etc. If gravel, indicate range or average size of gravel.		
water velocity range for holding adults	Reported range of observed (minimum and maximum) water velocity utilization.		
water velocity preference for holding adults	Reported range of most frequently observed water velocity utilization.		
other habitat characteristics for holding adults	General description of habitat (e.g. turbid or clear waters, lentic or lotic, presence of aquatic plant beds, debris, cover, etc.).		
timing range for adult holding	Time of year (earliest-latest) and duration of stay from upstream migration to spawning.		

Element	Element Descriptor	General	Feather River Specific
timing peak for adult holding	Time of year when maximum number of adults are present before spawning.		
Spawning			
fecundity	Average or range in the number of eggs females lay in a spawning season.	<p>The number of eggs females lay in a spawning season increases with body size, ranging from 50,000 to 200,000 eggs per female. The rate of fecundity is less than other species of sturgeon (Beamesderfer et al. 2002).</p> <p>The average number of eggs females lay in a spawning season is 127,500 eggs, and ranges from 51,000 to 224,00 eggs per female (Environmental Protection Information Center et al. 2001).</p> <p>Females typically lay 60,000 to 140,000 eggs in a spawning season. This rate of fecundity is lower in green sturgeon than in white sturgeon because green sturgeon are smaller and lay bigger eggs than white sturgeon (California Department of Fish and Game 2001; Habitat Conservation Planning Branch 2002; Surface Water Resources 2002; U.S.Fish and Wildlife Service 1995a).</p>	
nest construction	Location and general description of nest -- substrates, aquatic plants, excavations, crevices, habitat types, etc.	Green sturgeon spawn in deep, turbulent mainstems of rivers. Eggs are broadcast over large cobble where they settle into cracks (Beamesderfer et al. 2002).	
nest size	Size and average dimensions of the nest.		
spawning process	Indicate whether nest builder, broadcast spawner, or other.	<p>Green sturgeon do not build nests; instead, adults broadcast spawn into the water column (Pacific States Marine Fisheries Commission 1996).</p> <p>Green sturgeon are broadcast spawners (Surface Water Resources 2002; U.S.Fish and Wildlife Service 1995a).</p>	

Element	Element Descriptor	General	Feather River Specific
spawning substrate size/characteristics	Range of substrates used during spawning (e.g. mud, sand, gravel, boulders, beds of aquatic plants). Indicate presence of plant/wood debris, crevices at spawning sites. If gravel, indicate range of average size.	<p>Green sturgeon use clean sand to bedrock as spawning substrate (Environmental Protection Information Center et al. 2001).</p> <p>Green sturgeon spawn on substrates consisting primarily of cobble (Surface Water Resources 2002).</p> <p>Green sturgeon use clean sand to bedrock as spawning substrate (Surface Water Resources 2002; U.S.Fish and Wildlife Service 1995a).</p> <p>Green sturgeon prefer to spawn in the lower reaches of large rivers, with swift currents and large cobble (Pacific States Marine Fisheries Commission 1996).</p>	
preferred spawning substrate	Indicate preferred spawning substrate (e.g. mud, sand, gravel, boulders, plant bed, etc).	<p>Green sturgeon prefer to spawn in large cobble, with crevices in which eggs can become trapped and develop, and in areas with rocky bottoms (Beamesderfer et al. 2002).</p> <p>Green sturgeon prefer to spawn in large cobble (Environmental Protection Information Center et al. 2001; Surface Water Resources 2002; U.S.Fish and Wildlife Service 1995a).</p>	
water temperature tolerance for spawning	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	<p>Green sturgeon can spawn in water temperatures ranging from 46.4°F to 57.2°F (8°C to 14°C) (Habitat Conservation Planning Branch 2002; Moyle 2002; Surface Water Resources 2002).</p> <p>Green sturgeon tolerate spawning water temperatures ranging from 50°F to 70°F (10°C to 21.1°C) (California Department of Fish and Game 2001).</p>	
water temperature preference for spawning	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.	<p>Green sturgeon prefer to spawn in water temperatures ranging from 46.4°F to 57.2°F (8°C to 14°C). Green sturgeon require colder temperatures and clearer waters than white sturgeon (Environmental Protection Information Center et al. 2001; U.S.Fish and Wildlife Service 1995a).</p> <p>The range of optimal water temperatures for green</p>	

Element	Element Descriptor	General	Feather River Specific
		sturgeon spawning is unclear, but spawning success is related to this factor (Beamesderfer et al. 2002).	
water velocity range for spawning	Minimum and maximum speed of water current the spawning fish can tolerate.		
water velocity preference for spawning	Preferred water current (flow velocity) during spawning.	<p>The preferred water velocity for green sturgeon spawning is unclear, but spawning success is related to this factor (Beamesderfer et al. 2002).</p> <p>Fast water velocities are preferred by green sturgeon during spawning (Environmental Protection Information Center et al. 2001).</p> <p>Green sturgeon spawn in deep, fast-water (California Department of Fish and Game 2001).</p>	
water depth range for spawning	Reported range of observed (minimum and maximum) water depth utilization.	Green sturgeon spawn in holes greater than 9 feet (2.7 meters) in depth (Environmental Protection Information Center et al. 2001).	
water depth preference for spawning	Reported range of most frequently observed water depth utilization.	<p>Green sturgeon likely spawn at depths greater than 9.8 feet (3 meters) (Environmental Protection Information Center et al. 2001).</p> <p>Green sturgeon spawn at depths greater than 9 feet (2.7 meters) in relatively high velocity pool habitats (Surface Water Resources 2002; U.S.Fish and Wildlife Service 1995a).</p>	
range for spawning timing	Earliest and latest time of season or year in which spawning occurs.	<p>Green sturgeon spawn from March through July (Beamesderfer et al. 2002; Surface Water Resources 2002).</p> <p>In the Sacramento River, green sturgeon spawn from March through June; in the Klamath River, spawning occurs from March through July (California Department of Fish and Game 2001).</p> <p>Green sturgeon move to estuaries and the lower reaches of rivers between late winter and early summer, and ascend rivers to spawn in the spring and early summer. Adult green sturgeon leave the</p>	

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		<p>rivers soon after spawning (Environmental Protection Information Center et al. 2001).</p> <p>Green sturgeon spawn from March through July (Habitat Conservation Planning Branch 2002; U.S.Fish and Wildlife Service 1995a).</p>	
peak spawning timing	Time of year most fish start to spawn.	<p>Most green sturgeon spawn between April and June (Beamesderfer et al. 2002).</p> <p>Most green sturgeon spawn between mid-April and mid-June (Surface Water Resources 2002) (Environmental Protection Information Center et al. 2001; Habitat Conservation Planning Branch 2002; U.S.Fish and Wildlife Service 1995a).</p>	
spawning frequency (iteroparous/semelparous)	<p>Semelparous - producing all offspring at one time, such as in most salmon. Usually these fish die after reproduction.</p> <p>Iteroparous - producing offspring in successive, e.g., annual or seasonal batches, as is the case in most fishes.</p>	<p>Green sturgeon produce offspring in successive batches (iteroparous), although subsequent spawning may be delayed from 2 to 5 years (Surface Water Resources 2002).</p> <p>Spawning events may occur every 4 to 11 years (Grimaldo et al. 2001).</p>	
Incubation/early development			
egg characteristics	Shape, size, color, in clusters or individuals, stickiness, and other physical attributes.	<p>Green sturgeon eggs are considerably larger than other sturgeon eggs (Beamesderfer et al. 2002), and have a thin, chorionic layer. Green sturgeon probably require colder, cleaner water for spawning than white sturgeon (U.S.Fish and Wildlife Service 1995a).</p> <p>Green sturgeon eggs are slightly adhesive (California Department of Fish and Game 2001).</p> <p>Green sturgeon eggs adhere to each other and to river substrates (Surface Water Resources 2002).</p> <p>Green sturgeon egg size is approximately 0.15 inches (3.8 millimeters) (Habitat Conservation Planning Branch 2002; U.S.Fish and Wildlife Service 1995a).</p>	

Element	Element Descriptor	General	Feather River Specific
water temperature tolerance for incubation	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	Water temperatures above 68°F (20°C) are lethal to embryos (Beamesderfer et al. 2002).	
water temperature preference for incubation	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
time required for incubation	Time duration from fertilization to hatching. Note: Indicate at which temperature range. Incubation time is temperature-dependent.	<p>The time duration from fertilization to hatching is typically 4 to 12 days (California Department of Fish and Game 2001).</p> <p>The incubation period is 196 hours (8.2 days) at 54.9°F (12.7°C) (Environmental Protection Information Center et al. 2001; Habitat Conservation Planning Branch 2002; Surface Water Resources 2002; U.S.Fish and Wildlife Service 1995a).</p>	
size of newly hatched larvae	Average size of newly hatched larvae.	The average size of newly hatched larvae ranges from 0.71 to 0.74 inches (8 to 19 millimeters) (Environmental Protection Information Center et al. 2001; Habitat Conservation Planning Branch 2002; Surface Water Resources 2002; U.S.Fish and Wildlife Service 1995a).	
time newly hatched larvae remain in gravel	Time of year of hatching, and duration between hatching and emergence from gravel.		
other characteristics of larvae	Alevin -- early life history phase just after hatching (larva) when yolk-sac still present.	<p>Green sturgeon larvae do not have a pelagic dispersal stage (Beamesderfer et al. 2002).</p> <p>Green sturgeon larvae stay close to the bottom and rear in rivers upstream of estuaries. They do not move up the water column to avoid being transported downstream (California Department of Fish and Game 2001).</p>	
timing range for emergence	Time of year (earliest-latest) hatchlings (larvae and alevins) leave or emerge from the nesting/hatching (gravel) sites.		

Element	Element Descriptor	General	Feather River Specific
timing peak for emergence	Time of year most hatchlings emerge.		
size at emergence from gravel	Average size of hatchlings at time of emergence.		
Juvenile rearing (in freshwater)			
general rearing habitat and strategies	General description of freshwater environment and rearing behavior.		
water temperature tolerance for juvenile rearing	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for juvenile rearing	Range of suitable, preferred, or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
water velocity ranges for rearing juveniles	Reported range of observed (minimum and maximum) water velocity utilization.		
water velocities preferred by rearing juveniles	Reported range of most frequently observed water velocity utilization.		
water depth range for juvenile rearing	Reported range of observed (minimum and maximum) water depth utilization.		

Element	Element Descriptor	General	Feather River Specific
water depth preference for juvenile rearing	Reported range of most frequently observed water depth utilization.		
cover preferences for rearing juveniles	Type of cover for protection from predators used by rearing juveniles (e.g. crevices, submerged aquatic vegetation, overhanging vegetation, substrate cover, undercover bank, small woody debris, large woody debris).		
food base of juveniles	Indicate primary diet components. Also indicate the diet changes, if any, as growth occurs.	<p>The primary diet components for juvenile green sturgeon are small crustaceans, such as amphipods and opossum shrimp. As juvenile green sturgeon develop, they eat a wider variety of benthic invertebrates, including clams, crabs, and shrimp (California Department of Fish and Game 2001).</p> <p>In bays and estuaries, juvenile green sturgeon feed on mysid and opossum shrimps, annelid worms, isopods, crabs, and demersal fish. In streams, juvenile green sturgeon feed on insects, crustaceans, and annelids (Habitat Conservation Planning Branch 2002; Surface Water Resources 2002).</p> <p>Juvenile green sturgeon feed on shrimps and amphipods, small fish, and possibly mollusks (Beamesderfer et al. 2002).</p> <p>Juvenile green sturgeon in the Sacramento-San Joaquin Delta feed on opossum shrimp (<i>Neomysis mercedis</i>) and amphipods (<i>Corophium</i> sp.) (U.S.Fish and Wildlife Service 1995a).</p>	

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feeding habits of rearing juveniles	Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder. Also indicate change of feeding habits growth occurs.	Juvenile green sturgeon are opportunistic carnivores and are able to withstand long periods of food deprivation during times of limited food availability (Surface Water Resources 2002). Juvenile green sturgeon are benthic feeders (Beamesderfer et al. 2002).	
predation of juveniles	Indicate which species prey on juveniles.	Juvenile and adult green sturgeon have few natural predations, other than humans and large marine mammals (Surface Water Resources 2002).	
timing range for juvenile rearing	Range of time of year (months) during which rearing occurs.		
timing peak for juvenile rearing	Time of year (months) during which most rearing occurs.		
Juvenile emigration			
time spent in fresh water prior to emigrating	Duration (in years and/or months) from emergence to emigration to the ocean.	<p>Juvenile green sturgeon spend between 1 and 4 years in freshwater; leaving when they reach 1 to 2.5 feet (0.3 to 0.7 meters) in length (Beamesderfer et al. 2002; Environmental Protection Information Center et al. 2001).</p> <p>During their early lifestage, green sturgeon stay in freshwater for up to 2 years (Moyle 2002; U.S.Fish and Wildlife Service 1995a).</p> <p>Juvenile green sturgeon spend between 1 and 4 years in fresh water (California Department of Fish and Game 2001).</p> <p>Juveniles inhabit estuaries for 4 to 6 years before migrating to the ocean (Environmental Protection Information Center et al. 2001).</p> <p>Young-of-the-year (YOY) may rear up to 2 years in the river before migrating back to the estuary or ocean (Grimaldo et al. 2001).</p> <p>Juvenile green sturgeon migrate out to sea before 2</p>	

Element	Element Descriptor	General	Feather River Specific
		years of age (Habitat Conservation Planning Branch 2002). Juveniles inhabit the estuary until they are 4 to 6 years old (U.S.Fish and Wildlife Service 1995b).	
water temperature tolerances during emigration	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preferences during emigration	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
emigration timing range	Time of year juveniles commence emigration and duration of emigration	In the Klamath River, juvenile green sturgeon emigration occurs during the summer and fall (Surface Water Resources 2002). In the Klamath River, juvenile green sturgeon emigration occurs from late May through July (Environmental Protection Information Center et al. 2001). In the Trinity River, juvenile green sturgeon emigration occurs from early June through September (Environmental Protection Information Center et al. 2001).	
emigration timing peak	Time of year most juveniles are emigrating.	In the Klamath River, juvenile green sturgeon emigration peaks in September (Surface Water Resources 2002).	
size range of juveniles during emigration	Minimum and maximum sizes (inches or mm) of emigrating juveniles. Indicate average size.	In the Klamath River, juvenile green sturgeon range from 11.8 to 27.6 inches (30 to 70 centimeters) during emigration (Environmental Protection Information Center et al. 2001; U.S.Fish and Wildlife Service 1995a).	
Factors associated with emigration	Pulse flows, water temperature changes, turbidity levels, photoperiod, etc.		

Element	Element Descriptor	General	Feather River Specific
Other potential factors			
DO	Levels of dissolved oxygen in water expressed in mg/l tolerated by fish.		
pH	Alkalinity/acidity of water (expressed in pH) that fish can tolerate.		
turbidity	Indicate turbidity or state of water (e.g., clear water or presence of siltation or organic/inorganic matter in water) that fish can tolerate.	Silt prevents green sturgeon eggs from adhering to one another, and sand and silt may suffocate the eggs (Environmental Protection Information Center et al. 2001).	
factors contributing to mortality	e.g. fishing/angling mortality, drastic habitat alterations, unfavorable climatic changes, etc.	<p>Predation of green sturgeon is less than for white sturgeon because green sturgeon have lines of sharp, bony scutes along their bodies, making them less desirable prey (California Department of Fish and Game 2001).</p> <p>In Red Bluff, opening of the Diversion Dam gates during the green sturgeon spawning period has provided access to additional spawning areas upstream of Red Bluff (California Department of Fish and Game 2001).</p> <p>Green sturgeon are extremely vulnerable to overharvest and habitat degradation (National Marine Fisheries Service 2002).</p> <p>There has been an 88 percent decline in green sturgeon habitat (Musick et al. 2000), although this has been disputed (Beamesderfer et al. 2002).</p> <p>Green sturgeon are susceptible to bioaccumulation of toxic chemicals and to diseases from bacteria, protozoans, fungi, adenovirus, and white sturgeon iridovirus (Surface Water Resources 2002).</p> <p>Excess silt may prevent green sturgeon eggs from adhering (Surface Water Resources 2002).</p> <p>Likely factors negatively affecting green sturgeon</p>	A number of presumed spawning populations have apparently been lost in the last 25 to 30 years in California (e.g., South Fork Trinity River, Eel River), and the only known spawning populations are in the Sacramento, Feather, Klamath, and Rogue Rivers, all of which have flow regimes affected by water projects. It is highly probable that these are now the only green sturgeon spawning populations in North America (U.S.Fish and Wildlife Service 1995a).

Element	Element Descriptor	General	Feather River Specific
		abundance are: (1) fisheries; (2) modification of spawning habitat; (3) entrainment; and (4) toxic substances (Habitat Conservation Planning Branch 2002).	

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